

spermatozoids which are only a few seconds later than the first one. The penetration takes place at any point of the surface of the vitellus. I am of opinion that the normal fecundation of the starfish is effected by means of a single spermatozoid to each ovum; in the sea-urchin this fact is perfectly evident.

The point of penetration becomes the centre of a male star or aster; in the middle of the aster there is formed an aggregation or male pronucleus, which amalgamates with the female pronucleus exactly in the same manner as is observed in the sea-urchin. I need not, therefore, refer to it particularly.

From what precedes it results that the disappearance of the germinal vesicle and spot and the expulsion of the rejected materials are mere phenomena of the maturation of the ovule, and that the female pronucleus has no genetic connexion with the nucleolus of the ovule, and, lastly, that the spermatozoid exerts upon the vitelline material not only an attraction of contact, but even an attraction at a distance.—*Comptes Rendus*, Feb. 19, 1877, p. 357.

*On the Fecundation of the Egg in the Echinus.*

By M. J. PEREZ.

Every new fact relating to the fecundation of the egg being of considerable importance, it is essential not to regard it as definitively acquired in science until it has been subjected to careful checking. It is for this reason that I think it my duty to make known the observations that I have made upon the egg of *Echinus esculentus*, with the purpose of verifying the remarkable facts announced by M. H. Fol, in a note published in the 'Comptes Rendus' of the 19th February last.

I have twice had the opportunity of observing, at a point of the surface of the ovum, the projection described by M. Fol, and which that naturalist regards as raised by an *attraction at a distance* exerted by the spermatozoid nearest the vitelline sphere; but I found it impossible to ascribe to it the least importance in the act of impregnation. In fact, in one of the cases observed by me, no spermatozoid was at any moment opposite to this eminence up to the time of its disappearance by the rising of the vitelline membrane. In the second case a spermatozoid immersed in the mucous layer nearly at the middle of its thickness, after remaining motionless for a few seconds, moved briskly down to the apex of the projection. I saw no delicate prolongation of the latter emitted towards the spermatozoid; nor (and this is still more important) did I see the spermatozoid *flow*, according to M. Fol's expression, into the vitellus. It remained motionless, applied to the surface. Scarcely was it fixed there when another spermatozoid, following the same road as the first one, passed through the thickness of the mucous zone in two or three bounds, and also laid itself upon the surface of the little elevation. Two more spermatozoids took the same course, but stopped

about midway ; a fifth joined these, and then, after a few wriggings, disengaged itself and disappeared.

I watched persistently the two spermatozooids that adhered to the apex of the little elevation ; and my eye did not miss them for a moment. Their two bodies, laid side by side, always remained at the surface of the ovum ; and their tails were to be seen extended in the course which they had followed. Soon the vitelline membrane detached itself from the vitellus, and the projection ceased to exist ; but the two spermatozooids were still to be seen, elevated with the membrane, and quickly conveyed by it to a great distance from the yolk. The ovum was fecundated ; but no spermatozoid had penetrated into its interior.

One remark will be useful. In this observation the plane of vision passed through the centre of the ovum ; and the protuberance was exactly in this plane, at the equator of the ovum. If one of the spermatozooids had carried its body a little higher or a little lower by creeping upon the slope of the projection, this body, projected upon the latter, would have disappeared, whilst the tail might have remained visible beyond. In this way we should have the exact image of a spermatozoid penetrating into the ovum and leaving its tail out, just as M. Fol states he observed it.

The rising of an eminence at the surface of the ovum, in my opinion, has no connexion with fecundation. It is a simple accident which depends solely upon a solution of continuity in the mucous envelope (which is very frequent at least in the sea-urchin), constituting a point of weakest resistance at the surface of the ovum, and, in consequence, a corresponding deformation of the vitelline sphere. It will thus be understood why, of all the points of this sphere, the deformed part, when one exists, is usually the first attacked by the spermatic filaments. This deformation, reduced to a slight prominence in the case described by M. Fol and in that above mentioned by me, sometimes acquires exaggerated proportions, which, however, have no injurious effect upon the fecundation.

More than this, the penetration, as understood by M. Fol, clashes with an anatomical impossibility. That naturalist assumes, in fact, that the unfecundated ovum is destitute of vitelline membrane, and that this envelope originates only under the influence of fecundation. Now it is incontestable that it exists even in the very young ovum while the latter is still not granular : in this it is easy to observe it directly ; and the endosmotic action of pure water renders it still more evident. In the mature but unfecundated ovum of the *Echinus* a slight pressure, which clears its contents, suffices to show all round it a continuous uniform envelope, with a double contour, contrasting by its refringency and its orange-rose colour with the subjacent vitellus. It measures about  $\frac{8}{10000}$  millim. in thickness. When subsequently distended and removed from the vitellus, in consequence of impregnation, it becomes thinner and paler. The act of fecundation, therefore, does not determine the formation of the vitelline membrane, which existed long before ; as regards this

envelope, its only effect is to cause its inflation and its separation from the vitellus.

The presence of a proper membrane around the unfecundated ovum of the sea-urchin seems to me to be indubitable. We are not to imagine in this case a thin layer of hyaline non-granular protoplasm presenting only the appearance of a membrane. At the first glance a distinctly marked double contour renders any such interpretation impossible. If, therefore, it be supposed that the penetration of the spermatozoid is indispensable for fecundation, we have to inquire how it can get through such an obstacle, especially if we assume that this penetration can be effected at any point of the surface of the ovum.—*Comptes Rendus*, March 26, 1877, p. 620.

*On some Abnormal Fecundations in Starfishes.*

By M. H. FOUL.

In a former note I described the modifications undergone by the mature ova of *Asterias glacialis* when they are merely placed in sea-water, and the phenomena of an artificial fecundation performed with ova already freed from their polar materials. Let us now try the fecundation of the ova immediately after their escape from the ovary, or at least before the expulsion of the first polar corpuscle.

The details of the penetration of the zoosperms into the vitellus are very nearly the same as in the normal case. The principal difference is that the vitelline membrane is only very slowly formed and elevated round the point where the penetration is effected; instead of rapidly gaining the whole surface of the vitellus, it only extends over a portion of the periphery. Hence other spermatozooids have time to penetrate successively at different points of the surface of the ovule; and they continue to do so until the vitellus is completely enclosed in a membrane impermeable to the zoosperms.

The extent and rapidity of formation of the portions of the membrane which are differentiated round each point of penetration are very variable, and are less in proportion as the normal conditions are more widely departed from. In such cases I have counted as many as fifteen zoosperms in a single vitellus; and this number decreases as we operate under more normal conditions.

The body of the zoosperm flows into the vitellus; and at this point there is formed a clear spot surrounded by radiating filaments. This is the male aster. These male asters, starting from various points of the surface of the vitellus, travel slowly in the direction of its centre. Except as regards the number of asters, all this is in conformity with the normal case. If the fecundation takes place before the disappearance of the germinal vesicle, the male centres remain for a considerable time in a latent state, and it is only at the moment when the first polar corpuscle begins to issue, sometimes even already at the moment when the waste amphiaster is